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(54) Abstract Title
Device for the control of two electric units

(57) The device makes it possible to use an electrical appliance taking account of preferential electricity consumption tariff bands and whilst using only one supply line.

The device comprises, on the one hand, a logic control circuit (13) placed on a single supply line (12P, 12N, 12T) and controlling a first contactor (19) as a function of hourly tariff bands. It comprises, on the other hand, a control box (11) incorporating two thermostat contactors (16, 17), each relative to a heating element (2, 3) of a hot water tank (1) and a second contactor (15) supplying the lower heating element (2). The lower element (2) is only used during reduced tariff periods, the upper element (3) being used when requested by the user and inhibits the lower heating element (2).

The logic control circuit 13 receives output signals, both from an intensity measuring circuit 23 and a resistance measuring circuit 24 of the water heater elements, in order to control the heating elements as a function of these measured characteristics.

The device is applicable to all electrical appliances using two electric consumption units and in particular for accumulation heating by double power water heaters.

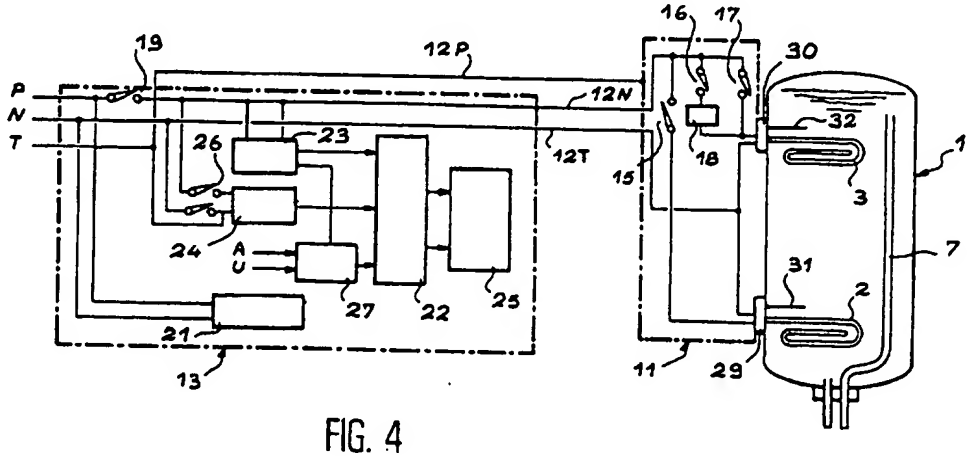

FIG. 4

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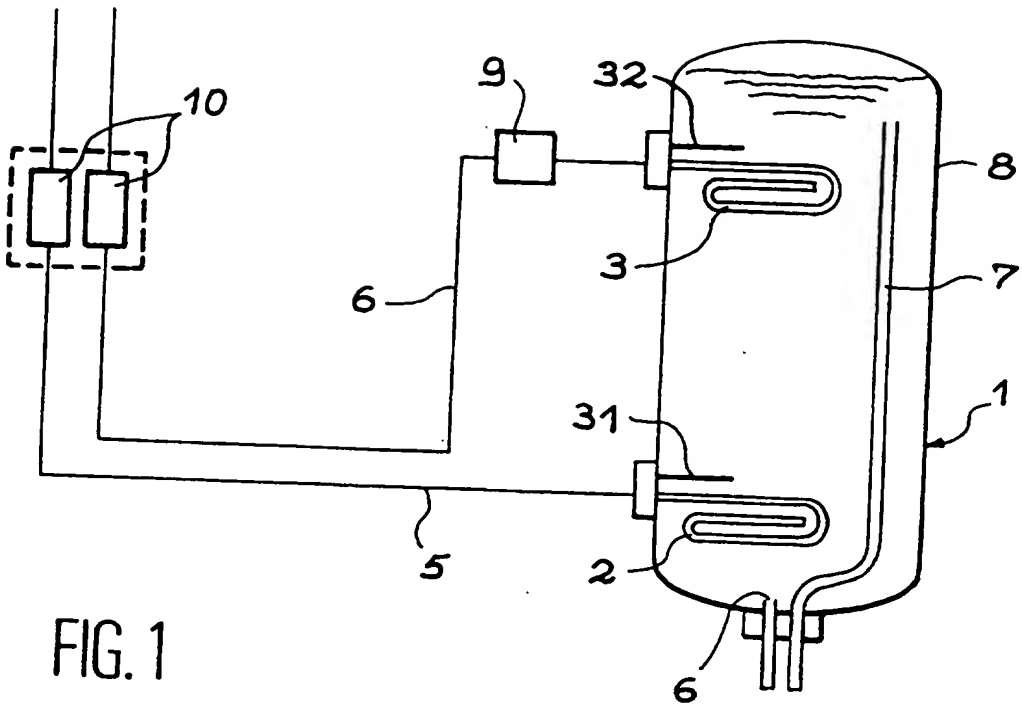

FIG. 1

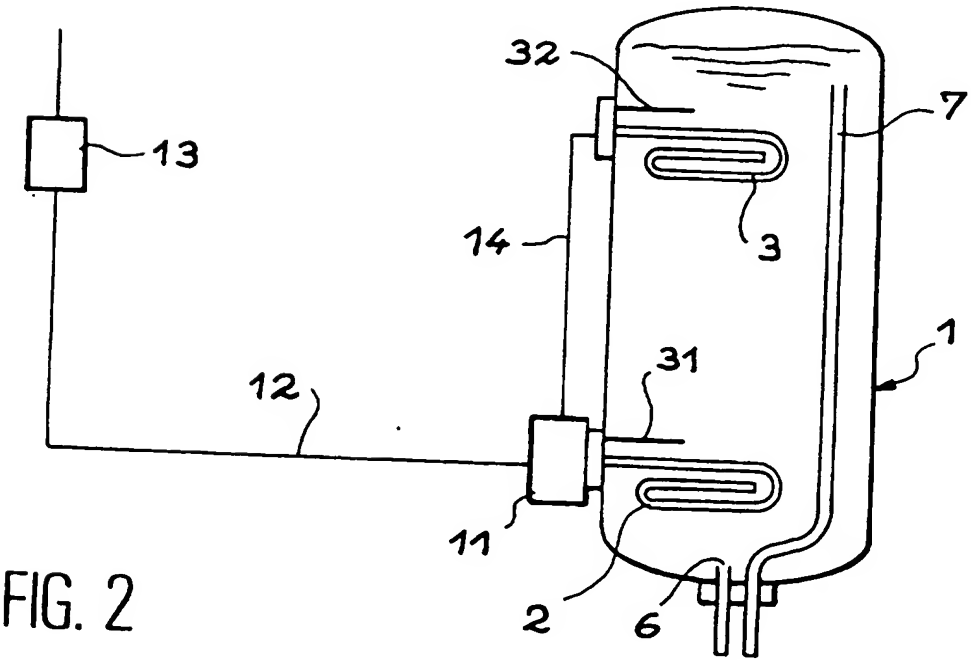

FIG. 2

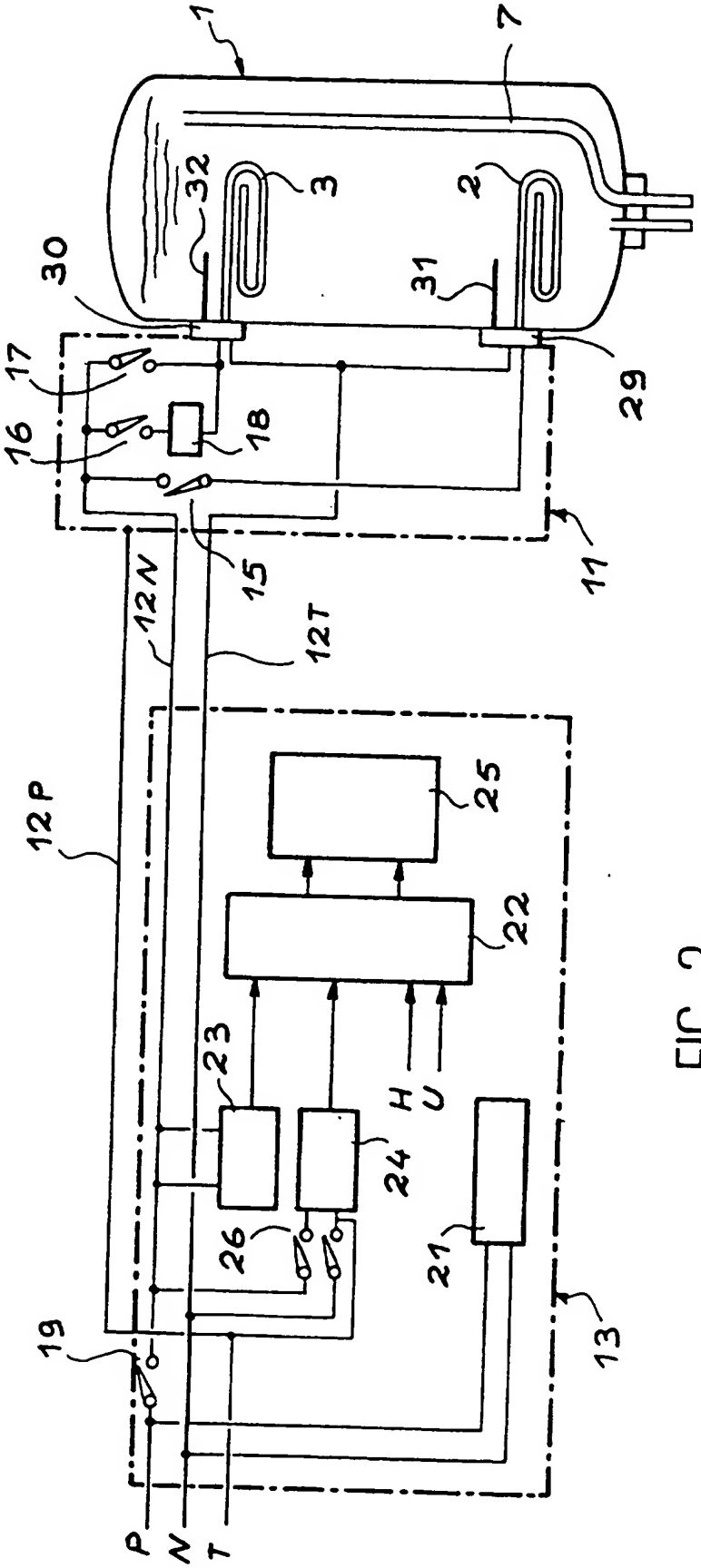
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FIG. 3

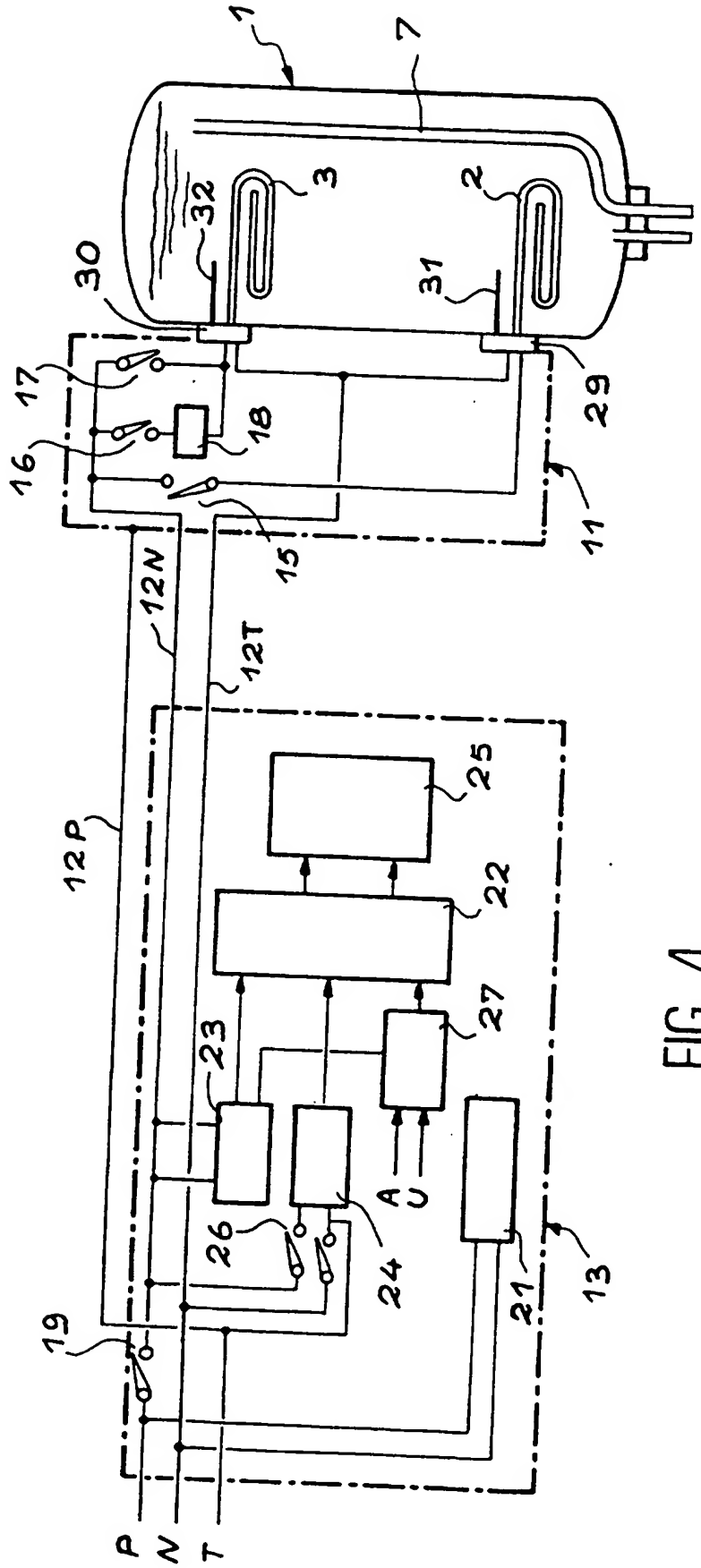
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FIG. 4

DEVICE FOR THE AUTOMATIC MANAGEMENT AND CONTROL OF TWO ELECTRIC UNITS AND APPLICATION TO A DOUBLE POWER WATER HEATER

DESCRIPTION

FIELD OF THE INVENTION

In general terms, the invention relates to appliances using two electricity consumption units having different operating conditions as a function of external parameters. It more particularly relates to double power water heaters, i.e. having two heating elements in a hot water tank. Such water heaters are used in numerous industrial and domestic premises, such as private apartments. The special operating feature of such water heaters is the use of reduced hourly tariff bands for electricity consumption for the purpose of heating all the water in the tank, so as to reduce the electricity use costs for the water heater.

PRIOR ART AND SET PROBLEM

With reference to fig. 1, the conventional, double power water heater 1 makes use of two heating elements, which are generally a lower electrical resistor 2 placed in the lower part of a hot water tank 8 and accompanied by a first thermostat 31 and an upper electric resistor 3 placed in the upper part of said same hot water tank 8 and accompanied by a second thermostat 32. These electrical resistors 2 and 3 are each supplied with electricity by a supply line, respectively 5 and 6. Each line has a circuit-breaker 10 placed in the electrical panel of the consumer. The tank 8 is completed by a water supply pipe 6 issuing into the lower part of the tank 8 and a hot water intake pipe 7 issuing into the upper part of said tank 8.

The lower resistor 2 is supplied during the hourly reduced tariff band periods for electrical consumption, i.e. during the night and consequently heats all the water contained in the tank 8 during this period. However, during the high tariff band period, namely during

the day, the mass of hot water initially contained in the tank 8 gradually cools as consumption occurs. Therefore the user can have a need to use the upper resistor 3 for heating the mass of water contained in the upper part of the tank 8, where is located the inlet for the hot water intake pipe 7. In this case, he operates a switch 9 for controlling the supply of the upper resistor 3. Moreover, the water consumption during the day can be high and the volume of the tank 8 will therefore be supplemented by the cold water supply using the cold supply pipe 6. Thus, the overall temperature of the water contained in the tank 8 will probably no longer be adequate to satisfy the user and the latter will need to partly heat the water using the upper resistor 3, by means of the switch 9 in order to heat the water in the upper part of the tank 8.

A major disadvantage of such a water heater and the adjoining installation, is that it is generally very difficult to install a second electricity line for supplying the water heater. This constitutes a handicap for the commercial development thereof. The aim of the present invention is to obviate this disadvantages.

Moreover, there is no communication or interaction between the two units, which are independent of one another. The consequence is that the two resistive heating elements can operate at the same time and consequently give rise to a high consumption of electricity.

SUMMARY OF THE INVENTION

Therefore, the main object of the present invention is a device for the control and automatic management of the power of an electrical appliance using two separate electric power consumption units from a single supply source, the first only being usable in a given time range. It comprises control means for controlling the operation of the first or second consumption unit in the given time range and that of the second consumption unit outside said given time range defined

by a time range signal, as a function of use request signals resulting from a measurement of an identified electrical quantity and characteristic of the automatic operating needs of the two units and by a need to use signal supplied by a contactor usable by a user as a function of his own needs and a single electric supply line for supplying the two units and controlled by the control means.

In the main embodiment of the invention, the control means comprise a control circuit placed at a random location and connected to an electric supply source receiving the first signal for measuring the electrical quantity by the supply line and the second signal, which is the need to use signal and control members placed on the one hand on the appliance and receiving the supply line and on the other, on said same supply line.

In the application of the device according to the invention to a water heater, the identified electrical quantity of the first signal being an electrical resistance, the control circuit comprises an intensity measuring circuit for measuring an intensity on the phase conductor of the electric supply line, a resistance measuring circuit of the water heater for measuring the resistance of said water heater in operation and a logic control circuit of the water heater receiving the measured intensity and resistance values and receiving a given time range signal and the need to use signal given by the switch in order to perform the measurement of the resistance of the water heater and control the control members as a function of the measurements.

Within the scope of the use of such a control circuit, the control members comprise a first contactor placed on the phase conductor of the supply line and in a control box placed on the water heater a first thermostat contactor for controlling the first unit formed by a heating element, a second thermostat contactor for controlling the second unit, which is also a heating element, a second contactor for

supplying the first heating element and a relay supplied by the second thermostat contactor for inhibiting the first heating element when the second thermostat is requesting.

In a preferred embodiment of the control circuit, use is made of a third contactor placed at the input of the resistance measuring circuit for connecting or not connecting the latter to the supply line and for measuring the resistance by injecting a current when the first contact is open.

In this case, the control circuit is advantageously completed by a time-delay circuit for ensuring that the first contactor and third contactor are not simultaneously supplied under transient conditions.

With the view of detecting any faults or breakdowns of the water heater, the control circuit can be equipped with a breakdown detection circuit connected to the supply line for detecting current passages to the first unit of the device and for optionally interrupting its supply.

LIST OF DRAWINGS

The invention is described in greater detail hereinafter relative to a non-limitative embodiment and with reference to the attached drawings, wherein show:

Fig. 1, already described, a diagram of a water heater equipped with the prior art device.

Fig. 2 a diagram of a water heater equipped with the device according to the invention.

Fig. 3 a diagram of the device according to the invention in its main embodiment.

Fig. 4 a diagram of the device according to the invention in a variant.

DETAILED DESCRIPTION OF TWO EMBODIMENTS OF THE INVENTION

With reference to fig. 2, the control device according to the invention is still used for controlling a water heater 1. By comparing with fig. 1, it is easy to see the difference between these two drawings, i.e. the presence of a single supply line 12 for the water heater 1. Thus, the latter has the same hot water tank 8 as that shown in fig. 1 and only the control members have changed. There is a single supply line 12 of a control circuit 13 placed at any random location on the supply line 12 and a control box 11 placed close to the water heater and receiving the supply line 12. This control box 11 comprises part of the control members of the water heater, the control circuit 13 comprising the other control members. In fig. 2, the control box 11 has been placed in the lower part of the water heater 1 facing the lower resistor 2. This only constitutes a possible embodiment and the control box 11 can be placed anywhere on the water heater 1. A secondary control line 14 makes it possible to supply the upper resistor 3, the control box directly supplying the lower resistor 2.

The control box 11 is shown in greater detail in fig. 3. Its main components and main connections are shown. The secondary supply 14 of fig. 2 has disappeared for representing the control circuit 11 on a larger scale and not at the scale of the water heater 1 and particularly its tank 8.

The single supply line 12 of fig. 2 is represented by its three conductors, namely a phase conductor 12P, a neutral conductor 12N and an earth conductor 12T.

The following members control the electrical supply of the two

heating elements 2 and 3, by means of the upper terminal block 30 and lower terminal block 29. A first contactor 19 is placed on the supply line, particularly on the phase conductor 12P. It is shown here forming part of the control circuit 13, but could also be positioned elsewhere. The supply of the two heating elements 2 and 3 by this phase conductor 12P takes place by two supply taps or branches using the phase conductor 12P of the upper heating element 3 on which are respectively located two thermostat contactors 16 and 17. There is also a relay 18 on the branch of the first thermostat contactor 16. This relay controls the opening and closing of a second contactor 15 placed on a third branch connected to the lower heating element 2 by means of the terminal block 29. Thus, when the first thermostat 31 requests heat, i.e. if the first thermostat contactor 16 is closed in the diagram of fig. 3, the relay 18 can be supplied, but assuming that the second thermostat 32 is not requesting heat, i.e. is not short-circuited by said relay 18 by being closed. In other words, when the second thermostat contactor 17 relative to the upper heating element 3 is closed, i.e. the upper heating element 3 is operating, the relay 18 keeps open the second contactor 15 placed on a tap or branch of the phase conductor 12P supplying the lower heating element 2.

Thus, the operation of the upper heating element 3 has priority over the operation of the lower heating element 2, at the request of the second thermostat 32 relative to the upper heating element 3.

If the first thermostat 31 is requesting and the second thermostat 32 is not, i.e. if the first thermostat contactor 16 is closed and the second thermostat contactor 17 open, the relay 18 closes the second contactor 15, thus supplying the lower heating element 2.

The control circuit 13 comprises an electric supply box 21 connected to the supply line and more specifically to the phase 12P and neutral 12N conductors. It also comprises a logic control circuit 22

receiving output signals, both from an intensity measuring circuit 23 and a resistance measuring circuit 24 of the water heater. The intensity measuring circuit 23 is shunted on part of the phase conductor 12P in order to measure the intensity of the current supplied and consumed by the water heater. The resistance measuring circuit 24 consequently measures the operating resistance of the water heater at the terminals of the phase 12P and neutral 12N conductors. Thus, account must be taken of the fact that the first contactor 19 placed on the phase conductor 12P is systematically open during a given time range corresponding to the high electricity tariff band periods. It is then impossible to know the possible operating resistance of the water heater without supplying current to its terminals. This is the objective of the resistance measuring circuit 24 which, by means of a third contactor 26, injects a low intensity current into the water heater in order to measure its resistance. When the first contactor 19 is closed, i.e. during the low tariff band periods, the intensity measuring circuit 23 measures the resistance of the water heater.

In order to permit the control of the first contactor 19 as a function of the tariff bands, the logic control circuit 22 receives a signal H characteristic of said bands. It also receives a signal U from a not shown switch and operated by the user, who may or may not be requesting a rise in the temperature of the water compared with the temperature normally obtained. This signal is called a comfort signal.

A time-delay circuit 25 completes the logic control circuit 22 so as to ensure that the first contactor 19 and third contactor 26 are not simultaneously supplied under transient conditions, which would lead to the failure of the overall system.

The operation of the device will now be explained. Thus, the control box 11 is designed in such a way that the first thermostat

contactor 16 can only supply the lower heating element 2 when the second thermostat contactor 17 is open, i.e. not requesting. Thus, the heating of the upper heating element 3 has priority over the heating of the lower heating element 2. Thus, it is impossible to have these two heating elements 2 and 3 operating at the same time.

During the high tariff band consumption periods, the input of the logic control circuit 22 receiving the signal H is activated. When the input receiving the signal U from the user is activated by a contact on the switch, the logic control circuit 22 must detect a request of the second thermostat 32 associated with the upper heating element 3 in order to authorize heating. If said second thermostat is requesting, the water heater is supplied, the first contactor 19 being closed. If said second thermostat 32 is not requesting, the water heater is not supplied, because the logic control circuit 22 opens the first contactor 19.

During the reduced tariff band consumption periods, the water heater is permanently supplied, because the logic control circuit 22 keeps the first contactor 19 closed. In the case of simultaneous requests from the two thermostats 31, 32, the upper heating element is supplied in priority manner, as explained hereinbefore. The lower heating element is only supplied when the upper heating element is not.

An example of the resistance measurement of the water heater will now be given. Resistance measurement takes place when the first contactor 19 is open and occurs by injecting a low direct current, the second contactor 15 being closed. If only the first thermostat 31 is requesting, the logic control circuit measures a resistance, e.g. exceeding 4 kΩ. If the two thermostats 31 and 32 are not requesting, the logic control circuit consequently measures an infinite resistance. If the second thermostat 32 is requesting, with or without the first thermostat 31 requesting, the logic control circuit 22 measures a resistance of the water heater of approximately 15 Ω, i.e.

the resistance of the upper heating element 3 only. Therefore the logic control circuit then decides to pass to current measurement by closing the first contactor 19 and opening the second contactor 15.

The measurement of the current injected into the water heater consequently takes place with the aid of the current measuring circuit 23 connected to a portion of the phase conductor 12P. When the second thermostat 32 is requesting, the measured intensity is approximately 16A. If the measured intensity drops below 10A, this means that only the first thermostat 31 is requesting and the logic control circuit 22 interrupts the supply by opening the first contactor 19. It then closes the second contactor 15 again in order to proceed to a possible future resistance measuring phase.

Such an automatic power management and control device has the advantages of limiting the power needed from the electricity distribution network, using a single appliance supply line and optimizing the comfort supplied.

With regards to the latter point, it is very interesting to use a circuit making it possible to detect a fault or malfunctioning of the water heater. Fig. 4 shows the same device as fig. 3, supplemented by a circuit of this type. Thus, a fault detection circuit 27 is incorporated in the control circuit 13. More specifically, it receives the output of the intensity measuring circuit 23 and the signals H relative to the hourly tariff bands and U the wishes of the user. This circuit 27 is a summating circuit.

Thus, if only the lower heating element 2 no longer functions or has failed and in the case of a low demand from the user, there is a risk of the latter not rapidly detecting the malfunctioning of the water heater. Thus, in this case, the hot water tank will be heated solely at the request of the user, using the upper heating element 3.

Thus, said fault detection circuit 27 counts the passages to reduced tariff bands. At the end of a given number N, e.g. 3 (which would correspond to 3 nights) in such an eventuality, the circuit 27 emits to the logic control circuit 22 a signal for the complete shutdown of the water heater. A reinitiating of the logic control circuit is possible by a general cutting out of the electric power supply. This makes it possible to resume heating during the high or low tariff band periods using the upper water heater and whilst awaiting for the repair of the complete water heater. This fault detection circuit 27 also provides for the systematic interruption of the operation of the lower heating element 2 when the upper heating element 3 is no longer functioning. In this case, the hot water tank cools and the user notices that it is not operating after a few hours. This fault detection circuit 27 is advantageously completed by a pilot light.

In the described, automatic power control and management device, i.e. applied to a water heater, the identified and measured, electrical quantity is the resistance of the water heater and its heating device, the heating elements being the consumption units. It is therefore readily possible to measure the impedances or capacitances of other equipment, e.g. motors, heat pumps, etc. Therefore said device can have a significant industrial application. The preferred application of this device is clearly to double power water heaters.

CLAIMS

1. Device for the automatic power management and control of an electrical appliance using two separate electric current consumption units from one power supply source, the first consumption unit (2) being usable solely in a given time range defined by a time range signal (H), the device comprising control means for controlling the operation of the first consumption unit (2) or the second consumption unit (3) in the given time range, and that of the second consumption unit (3) outside said given time range, defined by a time range signal (H), as a function of a use request signal given by measuring an identified electrical quantity characteristic of the automatic operating needs of the two consumption units (2, 3) and a need to use signal (U) coming from a contactor usable by a user as a function of his own needs and a single electric supply line (12N, 12P, 12T) for supplying the two units (2, 3), controlled by the control means.

2. Device according to claim 1, characterized in that the control means comprise a control circuit (13) placed at any random location and connected to an electric supply source and receiving a signal for measuring the identified electrical quantity by the supply line (12N, 12P) and the second signal, which is the need to use signal (U) and control members (11, 19), certain of which are placed on the appliance to be controlled and receiving the supply line (12N, 12P, 12T) and others being placed on a phase conductor (12P) of the supply line.

3. Device according to one of the claims 1 or 2, the controlled appliance being a water heater, the identified electrical quantity being an electrical resistance, characterized in that the control circuit (13) comprises an intensity measuring circuit (23) for measuring the intensity on the phase conductor (12P) of the supply line, a resistance measuring circuit (24) for measuring the resistance of the water heater and placed on the supply line (12P, 12N) and a logic

control circuit (22) receiving the measured values of the intensity measuring circuit (23) and resistance measuring circuit (24), receiving the time range signal (H) and the need to use signal (U) given by a switch for performing the measurement of the resistance of the water heater and for controlling the control members (19, 11) as a function of the measurements.

4. Device according to claim 3, characterized in that the control members comprise a first contactor (19) placed on the phase conductor (12P) of the supply line and in a control box (11) placed on the water heater a first thermostat contactor (16) relative to the first consumption unit (2), which is a lower heating element, a second thermostat contactor (17) relative to and controlling the second consumption unit (3), which is an upper heating element, a second contactor (15) for supplying the lower heating element (2) and a relay (18) for inhibiting the upper heating element (2) when the second thermostat contactor (17) is requesting.

5. Device according to either of the claims 3 or 4, characterized in that the control circuit (13) has a third contactor (26) placed at the input of the resistance measuring circuit (24) for connecting or not connecting the latter to the supply line (12P, 12N) and for measuring the resistance of the water heater by injecting an electric current when the first contactor (19) is open.

6. Device according to claim 5, characterized in that the control circuits (13) have a time-delay circuit (25) for ensuring that the first contactor (19) and third contactor (26) are not simultaneously supplied under transient conditions.

7. Device according to claim 2, characterized in that the control circuit (13) has a fault detection circuit (27) connected to the resistance measuring circuit (23) for detecting current passages and for interrupting the total operation of the latter when one of the two units (2, 3) is no longer operating.

Patent Office

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Application No:	GB 9813168.3	**Examiner:**	Paul Makin
Claims searched:	1-7	**Date of search:**	11 September 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): F4A (AC)

Int Cl (Ed.6): F24H 1/20, 1/48, 1/50

Other: Online : WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	GB 2250805 A	(GLEDHILL)	1
A	GB 2216242 A	(IMI RYCROFT)	1

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.